Invention Project
Title: Quiet Down!

Problem:
Our cafeteria is so noisy that it's hard to hear, even when people talk quietly. What can we do to cut down on the echo in there?

Research:
I looked into what causes sound problems in large rooms and I found out several things. First, when you can't hear people in our cafeteria, it may not be that the sound is too loud. It may be that the sounds all get mixed up. So that one person's talking gets mixed in with other people's talking. Second, if the surface of the walls, ceiling and floor are smooth, then they will bounce sound off of them more easily. Third, when sound bounces in a room with many flat surfaces, it will bounce in many directions. This is a lot like the ball in the computer game, "brickout."

I also found out that in places like cafeterias, when people try to talk and can't be heard, they talk louder. And the louder they talk the louder other people have to talk. Loudness is measured in decibels. Anything that will keep the sound from bouncing around so much will help to keep the sounds from getting mixed up and making everyone else talk louder. A surface that is porous and has many holes in it can trap sound so that not as much noise gets reflected.

Sources:
Iowa State University, Center for Non-Destructive Evaluation: http://www.ndt-ed.org/EducationResources/HighSchool/Sound/reflection.htm
High School Science Course, Glenbrook, IL, http://www.glenbrook.k12.il.us/gbssci/phys/Class/sound/u11l3d.html
American Speech, Language, and Hearing Association http://www.asha.org/public/hearing/disorders/noise.htm
Electro-Systems Acoustics http://www.alectrosystems.com/Acoustics/RoomEcho.htm

Solution:
I believe I should be able to reduce the bouncing around of the sound if I can change the surface of the walls to something soft or filled with holes. Two kinds of surfaces that should work are cloth and acoustical tile. I propose to cover the walls with cloth or acoustical tile.

Materials:

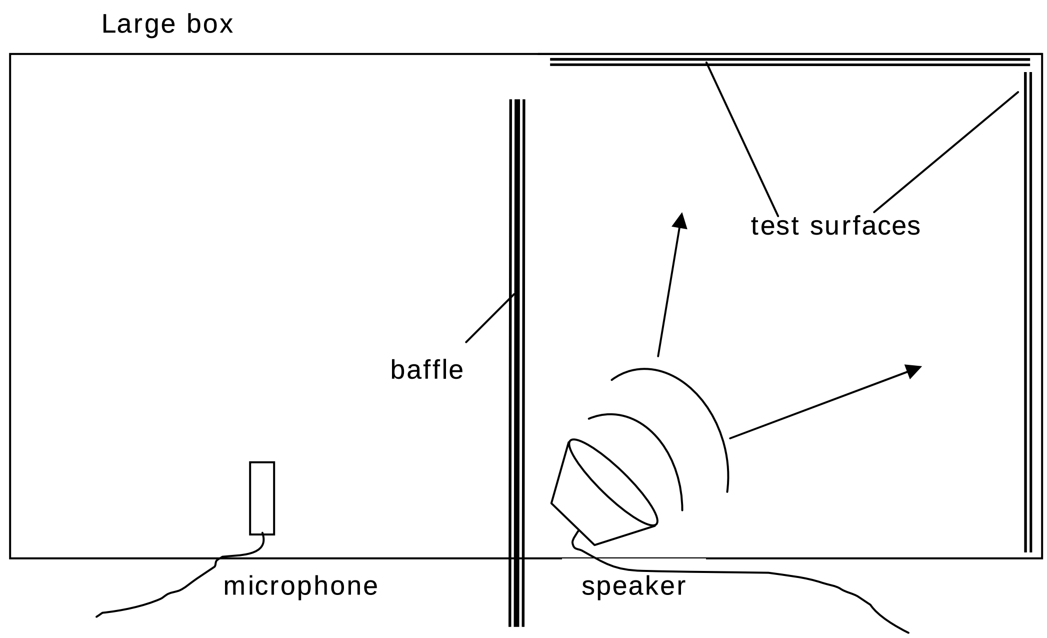
Large box: 112cm x 250cm x 92cm
Tape recorder with speaker
Laptop computer
Computer microphone
Baffle (91cm x 110cm)
Acoustic panels (125cm x 91cm)

- Rough plywood (2)
- Smooth panel board (2)
- Plywood covered with burlap (2)
- Acoustical ceiling tile (2)

Design:

Before the school will put anything up on the walls or ceiling, I need to prove that it will work. I constructed a sound test box. I used a large refrigerator box to do my testing. I divided up the inside of the box using a baffle made of Styrofoam so that the sound would not easily travel from one side of the box to the other. For the sound, I used a speaker connected to a tape player. The tape I used was recorded noise from our cafeteria. To "hear" the sound, I used a microphone connected to my computer. I used a computer program which shows a graph of the sound level coming into the microphone. I set both the speaker and the microphone on a blanket, to make sure that sound could not easily travel to the microphone through the box material itself.

My goal was to measure how much and what type of sound was bounced off of the surfaces of the walls of the box to the microphone. I used four types of material on the walls of the "room" in the box: plywood, smooth panel board, acoustic ceiling tile, and burlap cloth.



Set up:
I first tested the speaker directly to the microphone to get a sound check. I raised the volume to 70 decibels. When I measured the sound in our cafeteria using my computer the noise level was about 70 decibels on the average. I put both the speaker and the microphone on the blanket to do this. Then I placed the microphone and speaker into the box with a blanket under each one.

Safety note:
I wore ear coverings to be safe. I'm glad I did because 70 decibels is pretty loud on a speaker.

Next I used the same 30 seconds of tape and monitored the sound as it was reflected off the bare box and then each of the four types of panels. I recorded the sound and noted the highest decibel reading.

Data:

Type of covering	Trial 1	Trial 2	Trial 3	Average
Direct playback	71 db	71 db	71db	71 db
Bare box	68 db	69 db	67 db	68 db
Plywood	65 db	68 db	65 db	66 db
Smooth panel	68 db	69 db	70 db	69 db
Acoustic tile	50 db	48 db	49 db	49 db
Burlap fabric	45 db	47 db	44 db	45.3 db

Analysis:
The burlap fabric seems to work the best. It cut the decibel level almost in half. I could actually hear the difference when I listened to it myself. The acoustic tile did a pretty good job as well. As expected, the smoother surfaces allowed a lot of the noise to get through.

Conclusion:
If we can put cloth fabric on the walls of the cafeteria, we could reduce the noise. I was surprised to find that the cloth only reduced it a little bit. I thought that it would really make it quiet, but it reduced the level by only about half.